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SAE NTSB Vehicle Recorder TOPTEC Symposium Panel 1 Aviation

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engineering value
in aerospace

State of the Art Accident Recorder Technology - Aviation

Presentation Topics

The “Dynamic” Black Box - From Inception to Today

- **Aviation Recorder Survivability Evolution**
- **Aviation Recorder Media**
- **New Aviation Recorder Specification**
- **Combined Recorders**
- **Combined Recorder Installations**
- **Time Synchronization**

Aviation Accident Recorder Survivability Evolution

**Technical Standard Orders (TSO's) for Flight
Data Recorders (FDR) and Cockpit Voice
Recorders (CVR) have evolved:**

**C-51, C-51a, C-84, C-123, C-124, C-123a & C-124a, C-XXX
1958 —————→ 2003**

Crash Testing has Evolved to 3 Sequences

• Impact, Fire, Sea Water Immersion

- | | |
|--------------------------------|--|
| 1) Impact, Penetration, Crush, | High Temp Fire, Fluid Immersion |
| 2) Impact, Penetration, Crush, | Low Temp Fire, Fluid Immersion |
| 3) Impact, Penetration, Crush, | Deep Sea Pressure, Sea Water Immersion |

Aviation Accident Recorder Survivability Evolution

◆ Survivability Levels have Increased

- **Impact: 100g → 1000 g → 1700g → 3400g**
- **Penetration: None → 500 Lbs 10 Foot Drop 1/4 inch pin**
- **Static Crush: None → 5000 Lbs for 5 minutes each axis & diagonals**
- **1100°C Fire Test increased from 30 to 60 minutes duration**
 Flame coverage increased from 50% to 100%
- **Added Low Temperature Fire of 10 hours @ 260°C**
- **Seawater Immersion: Increased from 36 hours → 30 days**
- **Added Hydrostatic Pressure: equivalent to depth of 20,000 feet**

Aviation Accident Recorder Survivability Evolution

- ◆ **Survivability Levels have Increased (continued)**
 - **Fluids Immersion: None → 48 hours: Fuels, Hydraulic, Oil, TFF 8 hours: Fire Extinguishing Agents**
- ◆ **Underwater Location Beacon (ULB) attachment integrity**

Added impact testing of the most damage vulnerable direction to the ULB mount (could differ from most vulnerable direction of the crash survivable armor)

Aviation Accident Recorder Media

Aviation Recorder Media Evolution

Wire/Foil → Magnetic Tape → Solid State Devices

Solid State Media Advantages

- ◆ **Reliability Increases with Solid State memory**
- ◆ **Low Maintenance**
- ◆ **Significant increase in storage capacity**
 - **Magnetic tape not allowed (in future Spec)**
 - **Segregation of data types in memory devices**
 - **Combined audio no longer acceptable (in future Spec)**
merged crew channels for data older than 30 minutes
 - **Increase in data parameters from 5 to 88 plus**
 - **Provides potential for Image recording**

New Aviation Accident Recorder Specification

- ◆ EUROCAE Working Group 50 Drafted ED-112 the Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems
- ◆ Released March 2003
- ◆ New TSO C-XXX impending
- ◆ Replaces EUROCAE ED-55 and ED-56A specifications
- ◆ Harmonization of Airborne Recorders

Aviation Accident Recorder Specification

EUROCAE Working Group 50

WG 50 members are a composite of those involved with all aspects of Flight Recorders

- **Aircraft Manufacturers**
- **Airlines**
- **Pilots Unions: ALPA, IFALPA**
- **Investigative: NTSB, TSB, FRPC Canada, BEA, AAIB, BFU, Military Safety Center**
- **Government Regulatory: FAA, CAA, JAA, ICAO**
- **ARINC, EUROCAE, Eurocontrol**
- **Recorder and Equipment Manufacturers**
FDR, CVR, FDAU, Camera, Data Link, RIPS

Aviation Accident Recorder Specification MOPS ED-112

Why ED-112?

Added New Areas for Flight Recorders:

- **Automatically Deployable Recorders**
- **Combined Recorders**
- **Recorder Independent Power Supplies**
- **Image Recording**
 - ambient conditions in the cockpit; crew activity; instruments and control panels**
- **CNS/ATM**
 - flight path of the aircraft is authorised, directed or controlled, and relayed over a digital data link rather than by voice communication**

Aviation Accident Recorder Image Recording

Fundamental Need for Accident Investigation Image Recording:

Augment existing flight and audio data by capturing images of the cockpit to better understand the cockpit environment, flight crew interactions and the overall human/machine interface.

- **Cockpit environment**
- **Non-verbal crew communications**
- **Crew workload**
- **Instrument display selections and status**
- **Crash Protected**

New recorder to be known as the Airborne Image Recorder (AIR)

Aviation Accident Recorder Combined Recorders

NTSB Safety Recommendation A-99-17:

Recommends two combined recorders capable of 2 hours audio, 25 hours flight data and 2 hours Controller-Pilot Data Link (CPDL). One near cockpit and the other far aft.

ED-112 Combined Recorder:

- A single flight recorder that combines the functions of two or more accident recording functions in a single crash protected box.**
- Requires failure reporting for each particular function**
- Maintain functional segregation for two or more types of recordings (data link data may be combined with crew audio data)**

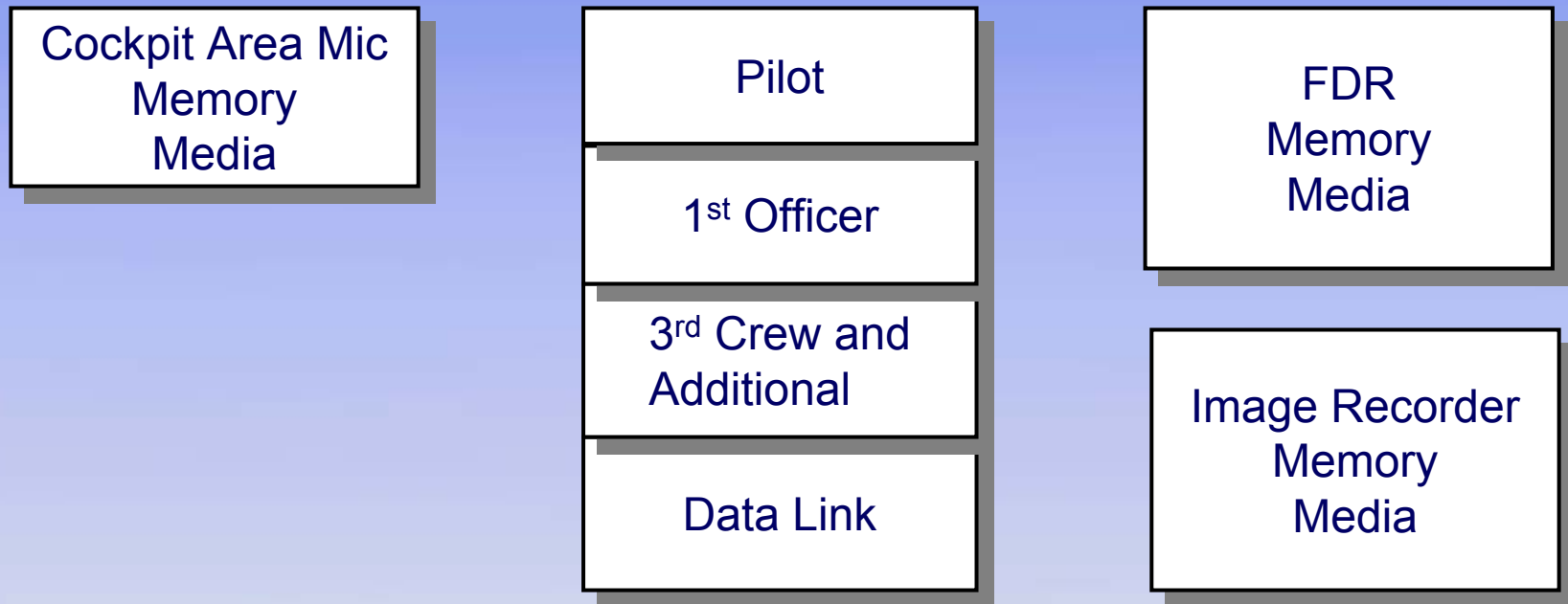
Aviation Accident Recorder Combined Recorder Installations

Two redundant, multi-function recorders installed in the forward and tail sections provides operational as well as accident investigation benefits

- ◆ **Increases the recovery probability of all information types (Audio, data, Image CNS/ATM)**
- ◆ **Aft location: Maximizes impact survivability**
- ◆ **Forward location: Maintain wiring integrity, crew co-location and RIPS integrity**
- ◆ **Possible Minimum Equipment List (MEL) time extensions**
- ◆ **Provides common parts, test equipment, and technical training**

Aviation Accident Recorder Combined Recorders

Recording medium Segregation and Partitioning



Prevents Loss of Recording Functions from a Single Memory Device

Aviation Accident Recorder Time Synchronisation

- **Synchronise with any other required recordings to within one (1.0) second**
- **Recommended that the recordings are capable of being synchronised in time with any other required recording to within 0.25 seconds**
- **Although synchronisation of 250 ms was technically achievable, it would require major modifications to aircraft, including wiring changes to and from critical systems**

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Summary and Conclusions

- **“Dynamic” Black Box**
- **Survivability requirements changed**
- **Recording media changes**
- **Specifications evolved**
- **Added new data types and recorder types**

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Thank You
SAE/NTSB TOPTEC

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